

Accessible science

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Hackers aim to make biology household practice

By Carolyn Y. Johnson, Globe Staff | September 15, 2008

CAMBRIDGE - In a third-floor loft where programmers build Internet start-ups, Mackenzie Cowell is talking about the tools he and like-minded young colleagues are using to fuel what they hope will be the next big thing in biology. The list includes a cut-up Charlie Card, ingredients bought on eBay to make a kind of scientific Jell-O, and a refrigerator, just scored on [Craigslist.com](http://craigslist.com), that chills to 80 degrees below zero.

Cowell is part of an effort called DIYbio - short for do-it-yourself biology - that aims to move science into the hands of hobbyists. It is starting by holding sessions where amateurs extract DNA, and attempt genetic fingerprinting using common household items and the kitchen sink.

"It shows you how much science can be about duct tape and having a few screws in the right place," Cowell said. "It shatters that clinical image."

What Cowell and crew hope to achieve is a democratization of science that could propel the field of biology into the mainstream, much as computer hackers fueled computer development a generation ago. After all, Silicon Valley's Homebrew Computer Club played a part in the personal computer industry and counts Apple Inc. founders among its attendees; Cowell would like DIYbio to be the Homebrew Club of Biology.

Cowell and his mostly 20-something friends are on a mission that seems inevitable to them, and is beginning to spark the attention, interest - and sometimes safety concern - of professional scientists. The recent shutdown of a lab in a retired chemist's home in Marlborough focused attention on the question of safety and the regulation of citizen scientists.

The idea of doing useful science at home isn't new. Backyard stargazers have long made contributions to astronomy. Bird-watchers participate in a wildlife census.

Now, enter the biohacker.

The movement is getting much of its steam from synthetic biology, a field of science that seeks to make working with cells and genes more like building circuits by creating standardized biological parts. The dream, already playing out in the annual International Genetically Engineered Machine competition at MIT, is that biology novices could browse a catalog of ready-made biological parts and use them to create customized organisms. Technological advances have made it quite simple to insert genes into bacteria to give them the ability to, for example, detect arsenic or produce vitamins.

"This follows in the heels of enormous American enthusiasm for invention that carries on in each generation," said Scott Mohr, a Boston University chemist who is writing a primer on synthetic biology.

"This is part of the same cycle: You go out there, you're an inventor, and you build mechanical stuff - my dad did that," Mohr said. "You go into computer programming and write viruses and video games. Those are the parents and older brothers of people who are going to do something even more thrilling" - experiments with living things.

But the work also raises fears that people could create a deadly microbe on purpose, just as computer hackers have unleashed crippling viruses or broken into government websites.

There is little formal regulation specifically for home labs. The state Department of Environmental Protection requires permits for businesses that create hazardous waste. Cambridge was the first city in the nation to pass a law regulating DNA research more than three decades ago, but it was intended to regulate professional scientists at universities and businesses, not individuals.

Still, authorities have discretion to act if they suspect wrongdoing. In 2004, Buffalo art professor Steve Kurtz was arrested and investigated as a possible bioterrorist because petri dishes and laboratory equipment were found in

his home in upstate New York, after his wife had died of a heart attack.

Tom Knight, a senior research scientist at MIT who is cofounding a synthetic biology company called Ginkgo BioWorks, sees the transformative value of biohacking - the phrase used to describe doing to living organisms what computer hackers have long done with electronics. But he has reservations about putting such power into the hands of amateurs.

"I think if the safety issues can be addressed, there is a big opportunity," Knight said. "It's a huge issue; how do you regulate so [people] don't cause havoc."

The promises and risks of biohacking were addressed in a paper this summer in the new journal *Systems and Synthetic Biology*. "A young crowd of enthusiastic biohackers . . . may spark a wave of innovation," wrote the coordinator of a European task force examining the implications of synthetic biology. But he cautioned that amateurs who don't adhere to a professional code of conduct and lack sufficient safety training raise the specter of biosafety and security risks.

The clash between the potential benefits and dangers of doing home science were highlighted by the case of Victor Deeb. The retired 71-year-old chemist in Marlborough saw his basement lab dismantled by authorities this summer after it was noticed by fire officials putting out a second-floor air conditioner fire.

The state DEP said officials intervened in Deeb's workspace because it did not meet lab standards. Chemical companies shipping Deeb their materials were unaware that they were shipping to a residence, authorities said.

Deeb, who said he was trying to make safer surface coatings for food containers, insists that the chemicals he was using were less hazardous than common cleaners and household chemicals. He questions why his hobby was seen as more dangerous than, for example, a hunter with a gun collection, or a person using a propane grill.

"The more I tried to explain, the more they thought I was a lunatic," Deeb said, questioning why he should need permits to tinker in his basement.

Not far from the loft where Cowell is trying to hatch his grass-roots scientific revolution, a group of synthetic biologists at MIT - whose business cards identify them as DNA hackers - are working with Knight to create a resource that could bring sophisticated biology techniques within reach of amateurs.

The company plans to provide standardized biological parts to biotech companies or clean fuel entrepreneurs, not casual garage scientists, but they see the excitement of what biohackers are trying to do. This summer, the company made a comic book-style protocol, with each frame showing how to do a bit of biological engineering, and brought it to a hacker expo, Foo Camp, where people made cells that smelled like banana or turned red.

"For us, it's a continuum," said Reshma Shetty, one of Ginkgo's founders. "We can make it easier for newcomers and professors" to do biology, "and make it so people can start biotech companies in their basement, just like they can build a Web 2.0 company in their basement."

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